

# **Curriculum vitae**

## **Biographical Summary**

Liang Zheng is a research scientist in Lawrence Berkeley National Lab. His research interests, which are centered on numerical modeling of non-isothermal, multiphase flow and multi-component reactive transport in porous media, and also include the inverse methodologies of parameter estimation, and coupled modeling of thermal (T), hydrodynamic (H), mechanical (M) and chemical (C) processes in the subsurface. During his Ph.D. work at the University of La Coruña, Spain, Liange conducted numerical simulations of geochemical evolution and corresponding thermo-hydromechanical processes in various porous media in the context of performance assessment of geological repositories for radioactive waste. His research work at LBNL is related to CO<sub>2</sub> geological sequestration, radioactive waste disposal and enhanced geothermal system (EGS). He has been working extensively on the study of the impact of CO<sub>2</sub> leakage on groundwater, focusing the potential release of trace elements in the shallow aquifer, the mobilization of organic compound by supercritical CO<sub>2</sub> and the effect of co-injected acid gas (i. e. H<sub>2</sub>S) on groundwater quality. He is also working on simulating the couple THMC processes in the engineering barrier system (bentonite) and host clay rock for radioactive waste disposal system and developing a new analytic-adaptive model for EGS assessment.

## **Education**

2001-2006	University of La Coruña, Spain, Ph.D. in civil engineering, 2006.
1998-2001	Jilin University, China, Master in Environmental Engineering, 2001.
1994-1998	Changchun Geology College, China, Bachelor in Environmental Engineering, 1998

## **Working Experiences**

09/2010– present.	Lawrence Berkeley National Laboratory
Job title:	Geological Research Scientist
03/2007 – 09/2010.	Lawrence Berkeley National Laboratory
Job title:	Geological Post Doctoral fellow
09/2001 – 3/2007._	University of la Coruña, Spain
Job Title:	Ph.D Candidate and Research Assistant

## **Scientific Papers & Works**

### **Refereed journals:**

1. Varadharajan, C., R. Tinnacher, J. Pugh, R. Trautz, **L. Zheng**, N. Spycher, J. Birkholzer, H. Castillo-Michel, R. Esposito, P. Nico. (2013) A laboratory study of the initial effects of dissolved carbon dioxide (CO<sub>2</sub>) on metal release from shallow sediments, submitted to International Journal of Greenhouse Gas Control, 19(0):

183-211..

2. Zhang, S., D. J. DePaolo, T. Xu and L. Zheng 2013. Mineralization of carbon dioxide sequestered in volcanogenic sandstone reservoir rocks. International Journal of Greenhouse Gas Control 18(0): 315-328.
3. Rutqvist, J., **L. Zheng**, F. Chen, H.-H. Liu and J. Birkholzer.( 2013). Modeling of coupled thermo-hydro-mechanical processes with links to geochemistry associated with bentonite-backfilled repository tunnels in clay formations. Rock Mechanics and Rock Engineering: 1-20, DOI 10.1007/s00603-013-0375-x.
4. **Zheng L.**, N. Spycher, J. Birkholzer, T. Xu, J. Apps and Y. Kharaka. (2013) On modeling the potential impacts of CO<sub>2</sub> sequestration on shallow groundwater: Transport of organics and co-injected H<sub>2</sub>S by supercritical CO<sub>2</sub> to shallow aquifers. International Journal of Greenhouse Gas Control 14(0): 113-127.
5. Trautz, R. C., J. D. Pugh, C. Varadharajan, **L. Zheng**, M. Bianchi, P. S. Nico, N. F. Spycher, D. L. Newell, R. A. Esposito, Y. Wu, B. Dafflon, S. S. Hubbard and J. T. Birkholzer. (2013). Effect of Dissolved CO<sub>2</sub> on a Shallow Groundwater System: A Controlled Release Field Experiment. Environmental Science & Technology 47(1): 298-305.
6. Viswanathan, H., Z. Dai, C. Lopano, E. Keating, J. A. Hakala, K. G. Scheckel, **L. Zheng**, G. D. Guthrie and R. Pawar. (2012) Developing a robust geochemical and reactive transport model to evaluate possible sources of arsenic at the CO<sub>2</sub> sequestration natural analog site in Chimayo, New Mexico. International Journal of Greenhouse Gas Control 10(0): 199-214.
7. **Zheng L.**, J.A. Apps, N. Spycher, J. T. Birkholzer, Y.f K. Kharaka, J. Thordesen, S. R. Beers, W. N. Herkelrath, E. Kakouros, and R. C. Trautz, (2012) Geochemical Modeling of Changes in Shallow Groundwater Chemistry Observed During the MSU-ZERT CO<sub>2</sub> Injection Experiment, International Journal of Greenhouse Gas Control. 7(0): 202-217.
8. Xu T. and **L. Zheng**, H. Tian. (2011), Reactive Transport Modeling for CO<sub>2</sub> Geological Sequestration, Journal of Petroleum Science and Engineering, 78(3–4): 765–777.
9. **Zheng L.**, J. Samper, and L. Montenegro. (2011) A coupled THC model of the FEBEX in situ test with bentonite swelling and chemical and thermal osmosis, Journal of Contaminant Hydrology, 126(1–2): 45–60.
10. Xu, T., E. Sonnenthal, N. Spycher, G. Zhang , **L. Zheng**, and K. Pruess. (2011) TOUGHREACT version 2.0: a simulator for subsurface reactive transport under non-isothermal multiphase flow conditions. Computer & Geoscience, 37: 763–774.
11. **Zheng L.**, J. Samper, L. Montenegro, A. M. Fernández. (2010) A coupled THMC model of a heating and hydration laboratory experiment in unsaturated compacted FEBEX bentonite. Journal of Hydrology, 386(1-4): 80-94.
12. Apps J. A., **L. Zheng**, Y. Zhang, T. Xu, J. T. Birkholzer. (2010) Evaluation of

- groundwater quality changes in response to CO<sub>2</sub> leakage from deep geological storage. *Transport in Porous Media*, 82: 215–246.
13. Kharaka, Y.K., J.J. Thordsen, E. Kakouros, G. Ambats, W.N. Herkelrath, J.T. Birkholzer, J.A., Apps, N. Spycher, **L. Zheng**, R.C. Trautz, H.W. Rauch and K. Gullickson. (2010) Changes in the chemistry of shallow groundwater related to the 2008 injection of CO<sub>2</sub> at the ZERT field site, Bozeman, Montana. *Env. Earth Sciences*, 60(2): 273-284.
  14. **Zheng L.**, J. A. Apps, Y. Zhang, T. Xu, J. T. Birkholzer. (2009) On mobilization of lead and arsenic in groundwater in response to CO<sub>2</sub> leakage from deep geological storage. *Chemical geology*, 268(3-4): 281-297.
  15. **Zheng L.**, J. Samper, L. Montenegro, J.-C. Mayor. (2008) Multiphase flow and multicomponent reactive transport model of Ventilation Experiment in Opalinus clay, *Physics and Chemistry of the Earth*, 33:S186-S195.
  16. **Zheng L.** and J. Samper. (2008) A Coupled THMC model of FEBEX mock-up test, *Physics and Chemistry of the Earth*, 33:S486-S498.
  17. **Zheng L.**, J. Samper and L. Montenegro. (2008) Inverse hydrochemical models of aqueous extracts tests, *Physics and Chemistry of the Earth*, 33(1009-1018).
  18. Samper,J., S. Dewonck, **L. Zheng**, Q. Yang, and A. Naves. (2008) Normalized sensitivities and parameter identifiability of in situ DIR diffusion experiments on Callovo-Oxfordian clay at Bure site, *Physics and Chemistry of the Earth*, 33: 1000-1008.
  19. Samper, J., **L. Zheng**, L. Montenegro, A. M. Fernández and P. Rivas. (2008) Coupled thermo-hydro-chemical models of compacted bentonite after FEBEX in situ test, *Applied geochemistry*, 23(5): 1186-1201.
  20. Samper, J., **L. Zheng**,, A. M. Fernández, L. Montenegro. (2008) Inverse modeling of multicomponent reactive transport through single and dual porosity media, *Journal of Contaminant Hydrology*, 98(3-4): 115-127.

#### **Recent presentations:**

1. **Zheng L.**, R. M. Tinnacher, C. Varadharajan, , M. Bianchi, N. F. Spycher, P. S. Nico, J. T. Birkholzer Trautz, R. C., J. D. Pugh, Numerical Interpretation of Laboratory and Field Data Showing CO<sub>2</sub>-induced Groundwater Changes, AGU fall meeting, 2012 San Francisco, CA.
2. **Zheng L.**, Marco Bianchi, Nicolas Spycher, Jens Birkholzer, Robert Trautz, Richard Esposito, Peter Nico, John Pugh, Charuleka Varadharajan, Reactive Transport Modeling of Dissolved CO<sub>2</sub>-induced Groundwater Change in a Field Experiment, 11th CCUS annual conference, April 30- May 3, 2012, Pittsburgh, Pennsylvania.
3. **Zheng L.**, J. Rutqvist, H.H. Liu, J. T. Birkholzer, E. Sonnenthal. Evaluating the geochemically induced swelling/shrinkage of the near-field host clay rock using a

THC model and the diffuse double layer theory. AGU falling meeting, 2011, San Francisco, CA.

**Non-refereed journals, books, proceedings:**

4. **Zheng L.**, J. Rutqvist, H.H. Liu, J. T. Birkholzer, E. Sonnenthal. (2013) chemical-mechanical coupling related to thmc modeling of clay formations, International High-Level Radioactive Waste Management (2013 IHLRWM), Albuquerque, NM.
5. Apps, J., **L. Zheng**, N. Spycher, et al. Transient changes in shallow groundwater chemistry during the MSU ZERT CO<sub>2</sub> injection experiment: Energy Procedia Volume: 4 Pages: 3231-3238 Published: 2011 DOI: 10.1016/j.egypro.2011.02.24
6. **Zheng L.**, N. Spycher, J. Apps, and J. Birkholzer. 2010. Potential impacts of CO<sub>2</sub> leakage on the quality of fresh water aquifers Water-Rock Interaction 2010, Guanajuato, Mexico, Taylor & Francis Group, London.
7. **Zheng L.**, J.A. Apps, N. Spycher, J. T. Birkholzer, Y.f K. Kharaka, J. Thordsen, S. R. Beers, W. N. Herkelrath, E. Kakouros, and R. C. Trautz, Geochemical Modeling of Changes in Shallow Groundwater Chemistry Observed in the ZERT CO<sub>2</sub> Injection Experiment. TOUGH Symposium 2009
8. Apps, J.A., Y. Zhang, **L. Zheng**, T. Xu, J.T. Birkholzer, Identification of Thermodynamic Controls defining the Concentration of Hazardous Elements in Potable Ground Waters and the Potential Impact of Increasing Carbon Dioxide Partial Pressure, GHGT-9, Energy Procedia 1 (2009) 1917–1924, Washington DC
9. **Zheng L.**, J.A. Apps, Y. Zhang, T. Xu, J.T. Birkholzer, 2D and 3D Simulations of Groundwater Quality Changes in Response to CO<sub>2</sub> Leakage from Deep Geological Storage, GHGT-9, Energy Procedia 1 (2009) 1887–1894, Washington DC.
10. **Zheng L.** and J. Samper. A dual continuum flow and reactive transport model for a long-term permeability test of FEBEX bentonite, in: GeoProc2006, 2006 International Conference on Coupled T-H-M-C Processes in Geosystems: Fundamentals, Modelling, Experiments and Applications, p350-356.
11. Samper J. and **L. Zheng**. Coupled THMC model for the FEBEX in situ test, in: GeoProc2006, 2006 International Conference on Coupled T-H-M-C Processes in Geosystems: Fundamentals, Modelling, Experiments and Applications, p97-108.
12. **Zheng L.** and J. Samper. A dual continuum reactive transport model with n-th order solute transfer term for structured unsaturated soils, accepted in: *Computer Methods in Water Resources*, 2006.
13. Samper, J. A.M<sup>a</sup> Fernández, **L. Zheng**, L. Montenegro, P. Rivas, A. Vázquez, Testing coupled thermo-hydro-geochemical models with geochemical data from FEBEX in situ test, In: Advances in Understanding Engineered Clay Barriers, , E. Alonso and A. Ledesma Eds, Balkema Pub., ISBN: 04 1536 544 9, 565-575, 2005
14. Samper, J. **L. Zheng**, J. Molinero, L. Montenegro. Reactive solute transport

mechanisms in nonisothermal unsaturated compacted clays, In: Advances in Understanding Engineered Clay Barriers, , E. Alonso and A. Ledesma Eds, Balkema Pub., ISBN: 04 1536 544 9, 525-533, 2005

15. Samper, J. A. M. Fernández, **L. Zheng**, L. Montenegro. Direct and inverse modeling of multicomponent reactive transport in single and dual porosity media, In: Advances in Understanding Engineered Clay Barriers, , E. Alonso and A. Ledesma Eds, Balkema Pub., ISBN: 04 1536 544 9, 493-503, 2005
16. **Zheng L.** and J. Samper. A dual continuum coupled multiphase flow model with mixed second order water transfer term for structured soil: I theory. VII Jornadas de investigación en la Zona no Saturada de Suelo, ISBN 84-9749-171-8, ZNS'05, Coruña , noviembre 16-17, pp295-301, 2005.
17. **Zheng L.**, J. Samper and L. Montenegro. A dual continuum coupled multiphase flow model with mixed second order water transfer term for structured soil: part II. Testing with synthetic cases and application to a real experiment. VII Jornadas de investigación en la Zona no Saturada de Suelo, ISBN 84-9749-171-8, ZNS'05, Coruña , noviembre 16-17, pp301-307, 2005.
18. **Zheng L.** and J. Samper. Inverse problem of non-isothermal multiphase flow and reactive transport in deformable porous media. VII Jornadas de investigación en la Zona no Saturada de Suelo, ISBN 84-9749-171-8, ZNS'05, Coruña , noviembre 16-17, pp307-313, 2005.
19. Samper, J., **L. Zheng** and L. Montenegro, THC modelling of the interface of granite-engineering barrier, 1st. Annual Workshop Proceedings 6TH EC FP - FUNMIG IP. Saclay (France) 28th Nov.- 1st. Dec. 2005.
20. Samper, J., C. Yang, **L. Zheng**, L. Montenegro Z. Dai and G. Zhang, CORE: A general purpose code for groundwater flow, heat and solute transport, chemical reactions and biological processes in porous and fractured media , EGU, Vienna, Austria, 24 – 29 April 2005.
21. **Zheng L.** and J. Samper. Formulation of the inverse problem of non-isothermal multiphase flow and reactive transport in porous media, En: *Computer Methods in Water Resources*, pp. 1317-1327, 2004.
22. Samper, J., **L. Zheng**, L. Montenegro, A. Vázquez y J. Molinero, Modelización de transporte geoquímico en bentonita (Proyecto FEBEX II). En: *V Jornadas de Investigación y desarrollo Tecnológico en gestión de residuos radiactivos, Tarragona, Septiembre, Publ. Tecn. ENRESA 6/2004, Vol IV, ISSN: 1134-380 X*, pp. 142-173, 2004.
23. Samper, J., A. M. Fernández, **L. Zheng**, L. Montenegro, P. Rivas, and Z. Dai. Forward and inverse modelling of multicomponent reactive transport in single and double porosity media, En: *Computer Methods in Water Resources*, pp. 805-816, 2004.

24. **Zheng L.**, J. Samper, X. Dai. Desarrollos conceptuales y numéricos en la estimación de parámetros de flujo, transporte y geoquímicos mediante modelización inversa del flujo y transporte de solutos radioactivos: aplicaciones a ensayos de laboratorio e in situ, En: *V Jornadas de Investigación y desarrollo tecnológico en gestión de residuos radiactivos, Tarragona*, Ed. ENRESA, p. 141 (sinopsis de póster), 2003.
25. Samper, J., **L. Zheng**, L. Montenegro, A. Vázquez y Ch. B. Yang, Campo Próximo: Desarrollos conceptuales y numéricos en el campo de los modelos acoplados THG para bentonitas: experiencias del Proyecto FEBEX, En: *V Jornadas de Investigación y desarrollo Tecnológico en gestión de residuos radiactivos, Tarragona*, Ed. ENRESA, p.55 (sinopsis de póster), 2003.
26. Samper, J. A. M. Fernández, **L. Zheng**, L. Montenegro, P. Rivas y Z. Dai. Modelización directa e inversa del transporte reactivo multicomponente en medios de doble porosidad, En: *VI Jornadas de Zona No Saturada, Valladolid. Temas de Investigación en Zona no Saturada, Valladolid*, pp.261-268, 2003.
27. Samper, J., A. M. Fernández, **L. Zheng**, L. Montenegro, P. Rivas y Z. Dai. Calibration and inverse modelling of multicomponent reactive transport in single and dual porosity media, En: *Eos Trans. AGU, Fall Meeting, San Francisco. Diciembre 2003.*, Abstract, 2003.
28. **Zheng, L.**.. and Zhao Yongsheng (2000). “Landfill barrier-overview and prospect”. Journal of Geoscience Research in Northeast China. No.1, Vol.3, 87-98 pp.
29. Zhao Y. and **L. Zheng**(1999). “The waste disposal in China and counteract”. World of Geology, No.2.

## Report

1. **Zheng L.** J. Houseworth. (2013), Report on THMC Effects on Radionuclide Transport in a Clay Repository, Lawrence Berkeley National Laboratory, FCRD-UFD-2013-000245.
2. Liu, H.H., J. Houseworth, J. Rutqvist, **L. Zheng**, D.e Asahina, L. Li, V. Vilarrasa, F. Chen, S. Nakagawa, S. Finsterle, C. Doughty, T. Kneafsey and J. Birkholzer. (2013) Report on THMC modeling of the near field evolution of a generic clay repository: Model validation and demonstration, Lawrence Berkeley National Laboratory, August, 2013, FCRD-UFD-2013-0000244.
3. Davis, J. J. Rutqvist, C. Steefel, R. Tinnacher, V. Vilarrasa, **L. Zheng**, I. Bourg, H.H. Liu, J. Birkholzer. (2013) Investigation of Reactive Transport and Coupled THMC Processes in the EBS: FY13 Report, Lawrence Berkeley National Laboratory, July 16, 2013, FCRD-UFD-2013-000216
4. **Zheng L.**, L. Li, J. Rutqvist, H.H. Liu and J. Birkholzer, Modeling radionuclide transport in clays, 05/2012, FCRD-UFD-2012-000128.
5. **Zheng L.**, H.H. Liu, J. Birkholzer and M. Nutt, 2011, Diffusion Modeling in a Generic Clay Repository, Lawrence Berkeley National laboratory 07/2011.

6. **Zheng L.**, J. Rutqvist, J. Houseworth, J. Davis, R. Tinnacher, L. Li and H.H. Liu, 2011, Investigation of near-field THMC coupled processes, Lawrence Berkeley National Laboratory, Project Report 07/29/2011
7. **Zheng L.**, N. Spycher, J. Birkholzer, T. Xu, J. Apps, Y. Kharaka, 2010. Modeling Studies on the Transport of Benzene and H<sub>2</sub>S in CO<sub>2</sub>-Water Systems, Lawrence Berkeley National Laboratory, Project Report LBNL-2931E
8. Ambats, G., J.A. Apps, S. Beers, J.T. Birkholzer, K.S. Gullickson, W.N. Herkelrath, E. Kakouros, Y.K. Kharaka, L.H. Spangler, N. Spycher, J. Thordesen, **L. Zheng.** (Authors by alphabetical order). (2009) Groundwater chemistry changes as a result of CO<sub>2</sub> injection at the ZERT field site in Bozeman, Montana. Lawrence Berkeley National Laboratory, Project Report LBNL-2931E.
9. Birkholzer, J., J. Apps, **L. Zheng**, Y. Zhang, T. Xu, C. Tsang. Research Project on CO<sub>2</sub> Geological Storage and Groundwater Resources: Water Quality Effects Caused by CO<sub>2</sub> Intrusion into Shallow Groundwater. Lawrence Berkeley National Laboratory Technical Report No. LBNL-1251E. (2008), 450 p.
10. Samper, J., **L. Zheng**, and L. Montenegro, 2005. Final THG modelling report (Deliverable D25). 70-udc-m-6-20, E.T.S ingenieros de Caminos, Universidad de La Coruña, a coruña.
11. Samper, J., **L. Zheng**, A. Vázquez & C. B. Yang, Modelización hidrogeoquímica de la arcilla española de referencia, Informe Técnico elaborado para ENRESA, L. Montenegro, E. T. S. Ingenieros de Caminos. Universidade da Coruña, La Coruña, Agosto, 2003 (Spanish)
12. Samper j.; C. Yang, B. Veiga, L. Montenegro, **L. Zheng**, & J. Molinero, ACTUALIZACIÓN DEL MODELO DE FLUJO Y TRANSPORTE DE ANDÚJAR, Report, Enresa and Universidad da Coruña, August, 2004 (Spanish).
13. Samper, J. M. Bonilla, **L. Zheng**, J. Molinero. Evaluación del impacto de las obras del eje atlántico de alta velocidad en el tramo padrón-osebe sobre las captaciones de agua y calculo de aporte de agua al túnel, Universidades de a Coruña y Santiago de Compostela. Agosto, 2004
14. Samper J. and **L. Zheng**, deliverable (D-Nº: D5.1.2) report on mass balance and mass flow—contribution of UDC: V Calculation of H<sub>2</sub> buildup and diffusion through the bentonite for a repository in granite. NF-PRO project, Contract Number: FI6W-CT-2003-02389, 30/07/2005
15. Samper J. and **L. Zheng**, deliverable (D-Nº: D5.1.2) report on mass balance and mass flow—contribution of UDC: VI. Geochemical evolution during the hydration phase in a SF carbon steel repository in granite. NF-PRO project, Contract Number: FI6W-CT-2003-02389, 30/07/2005
16. Samper, J. C. Yang, Q. Yang, L. Montenegro, **L. Zheng**, and M. Bonilla deliverable (D-Nº: D5.1.2) report on mass balance and mass flow—contribution of UDC: IV. calculations of the long term geochemical evolution of a spent-fuel

carbon-steel canister repository in clay: sensitivity analysis to bentonite accessible porosity. NF-PRO project, Contract Number: FI6W-CT-2003-02389, 30/07/2005

17. Samper, J. C. Yang, C. Lu, L. Montenegro, **L. Zheng**, and M. Bonilla deliverable (D-Nº: D5.1.2) report on mass balance and mass flow—contribution of UDC: III. Calculations of the long term geochemical evolution of a spent-fuel carbon-steel canister repository in granite. NF-PRO project, Contract Number: FI6W-CT-2003-02389, 30/07/2005